Autobiography of a Canadian ATM

(ATM = Amateur Telescope Maker)

By: James E. Gort, Ph.D.

I am a Canadian. But, like so many others, I am also an immigrant. My story begins outside of Canada. So we'll start at the beginning.

I was born on Thursday, February 13, 1947, in St. Mary of Nazareth Hospital, Chicago, Illinois. My mother, Stephanie, was a seamstress who had given up her day job to raise her three children, of whom I am the youngest. My father, Edmund, was a "master printer craftsman", who was one of the original employees of John Dickinson Schneider Printing in Chicago, having started in the early 1920's, and helped build the business. That company became Hollister Incorporated, a multinational.

My parents purchased their first and only house in 1937, located at 2708 N. Rutherford Avenue in Chicago, on the NorthWest side. A beautiful middle class neighbourhood. I lived there during my youth, until I went to college and moved away.

My childhood was idyllic. With no exaggeration, my mother sang songs to me (both during the day and at bedtime) and my father was brilliant – always building things in the basement, fixing his car, or just puttering. And he always read bedtime stories to me. He was an avid reader, especially math and science. I remember that we had a tattered copy of the Popular Science book of questions and answers. That book alone did more to pique my interest in science than anything else.

Dad was the most even-tempered man I've ever met. Never heard him say a cross word about anybody. Never raised his voice to my mother, my siblings, or me. When someone cut him off on the road, the worst he would say is "Move over, you Lug." He took me fishing to Lake Michigan (at 5:00 am) and to the golf driving range. Nothing but great memories!

I was indeed fortunate to have parents like that. And fortunate to have an older brother, Rich, who was my mentor. I'm sure Rich was influenced by my father, since he liked to build things too. Some of my earliest memories were of crystal radio sets that Rich and Dad would put together, as I watched and "helped". I was perhaps 6 years old then. Rich was 10 or 11 (he was four and a half years older).

His love of radios and all things electronic introduced me to that fascinating area. He'd take me on the bus (Chicago Transit Authority – Bus #76) to Allied Radio and Olson Radio on Western Avenue for

electronic parts. I don't remember what he built, but I built several transistor radios between 1955 and 1957 from plans in Popular Electronics. I loved that magazine. Waited for it to come out every month so I (or my brother) could spend my/his allowance on the next issue. Around 1955, Rich (and many of his friends) became interested in ham radio. I, like the little follower I was, followed. To become a ham, of course, you needed to learn Morse code. So I started reciting Morse code every day in my one-block walk to Locke School. Out loud, I'd say "A is dit-dah" over and over. School kids would start calling me "A's dit-dah". I didn't care. I was determined. We (or probably just Rich) built a code practice machine. And I seem to remember a tape (or record) with Morse code for practice. We (or just Rich) bought the American Radio Relay League (ARRL) licence guide from Allied to practice for the written exam. Anyway, in early 1957, Rich took the Novice ham exam from a ham neighbour (Frank - W9ZIV) and passed. He got his license about 8 weeks later – KN9INW. Later, in the same year, I also took the exam. I remember it well. I took the Morse code part first and easily passed (at 5 words per minute). The written test was multiple choice, dealing with basic radio knowledge (like Ohm's law), basic Federal Communications Commission (FCC) rules, and knowledge of allowed frequencies. I remember sniggering at the "silliness" of some of the choices, but Frank thought I was whimpering. He suggested that I skip the "hard" ones. I explained that some choices were just plain silly. But I passed, and in 8 weeks or so, I, too, was a licensed ham at 10 years old– KN9JUW. Rich had previously built a home-brew "rig" (transmitter) and receiver from a kit. I used that "ham shack" but eventually built my own kits – a Knight 50 transmitter, a Knight Ocean Hopper receiver and others.

We, of course, upgraded our transmitters/receivers several times, while working to improve our code speed to 13 words per minute (required for the General exam). The Novice license was only good for one year! And the General exam required a much more thorough knowledge of radio theory and practice, including the free-hand drawing of 5 schematic diagrams of various types of transmitters / oscillators / power supplies. So, in 1958, Rich and I went together to the FCC office building in downtown Chicago to take the General exam – supervised by the "FCC District Engineer in Charge." It was a large, intimidating room filled with test-takers. Some were receiving code with their earphones on, while others were hunched over the desks taking the written portion. At the end of the day, Rich passed and I failed the code receiving test. I could easily receive more than 13 words per minute at home, but when I got to that intimidating room, I was just so nervous. I had to wait several weeks before a re-test, but I tried again and failed. Not wanting to have my Novice license expire and lose my coveted call sign (they were alphabetically assigned – the earlier ones were more coveted), I decided to take the Technician exam. This was the same written test as the General exam, but only 5 words per minute code test. Technicians, of course, were restricted to 6 meters and a few other bands. But it was better than nothing. So I took the Technician exam and easily passed, so my call changed to K9JUW. But I had to take the General exam several more times (6 in total) before I finally passed. By then, I was 13 years old.

Ham radio was lots of fun, and I talked (by phone and Morse code) to hams around the world. Received hundreds of colourful "QSL" cards to formally acknowledge the contacts. I remember the state police calling my mother's unlisted telephone one day, saying that some "girl" was interfering with their police radios, and to cut it out! My youthful voice was, of course, the "girl" and the interference was caused by my inexpensive transmitter. But around that time (age 13), I was looking for other things, too. Briefly

dabbled in microscopy after reading Paul de Kruif's "Microbe Hunters". But then, in 1960, I bought a little paperback (at Sears) entitled "The Individual and the Universe" by Sir Bernard Lovell. I was hooked. Astronomy seemed fascinating. I bought another paperback – "New Handbook of the Heavens". It talked about telescopes, and how refractors were more practical for beginners. So I now needed a telescope! Through the Yellow Pages, I found The American Science Center at 5700 Northwest Highway, 5 miles from my house. They had the "perfect" telescope - a 3" refractor – for $125. I could never afford that – even with my recently raised "high school" allowance of $1.00 per week. But my wonderful mother came up with an idea – she would lend me the money, and I would slowly pay her back with my allowance and paper route earnings. So I actually bought an Edmund 3" refractor! NB – I still have it and cherish it.

My Dad drove me to the American Science Center (ASC) to pick up the scope. I couldn't wait to bring it home and set it up. I didn't wait for nightfall. The moon was out and I pointed it at the moon. I was aghast. I remember reading in the New Handbook of the Heavens that an observation not recorded is an observation wasted. So I pulled out a school notebook and started to record everything I saw on the moon. The book I had included a lunar map, so I noted the crater names and what I saw in detail. The New Handbook had lists of double stars, variable stars, and nebulae, and I dived into them all. In one of my frequent 5-mile bicycle trips to the American Science Center, I purchased Hubble's "The Realm of the Nebula" and Shapley's "Galaxies", which prompted me to do more deep sky hunting with my little 3" refractor under Chicago's light polluted skies. I soon upgraded the refractor the best I could – adding setting circles and an Edmund clock drive, all purchased from the same ASC. I even attached my little brownie camera with Tri-X film to the scope and shot many passable pictures, mostly of the moon but a few of Jupiter, Saturn, and even the comet Ikeya-Seki. Most importantly, every observation was recorded in my little notebook, identifying the date/time, temperature, humidity, sky conditions, power, and my visual impressions at the eyepiece.

Many of my evenings during 1961-1964 were spent observing and recording the observations. But during the summer of 1962, I made a fateful bicycle trip to ASC and found yet another book that was destined to affect me for the rest of my life. On a shelf in the store, I noticed "How to Make a Telescope" by Jean Texereau. I thumbed through its pages and stopped when I saw some photos of M104 – the Sombrero Galaxy – taken with a 10" Newtonian reflector. Why not make a 10" telescope? I thought "I can do that" and "it looks like fun". The book was actually geared towards a "standard 8" telescope", but I wanted to go for the 10". M104 looked so inviting, and I didn't think my scrawny arms could handle the weight of a 12 and a half-inch glass. ASC, of course, sold the mirror kits, complete with abrasives, polishing agents, and pitch, so I once again got my savings together and bought the kit. Texereau also came home with me and has been my close companion ever since. Another cherished possession.

I soon got to work in our large basement at Rutherford to set up a mirror grinding place. We had a utility sink there (for washing grit off) and an old gas range (for melting pitch). And fairly even temperatures for testing purposes. The perfect location!

I followed Texereau to the letter. I found a small, sturdy table that I could walk around for grinding the mirror and set to work with #80 grit. Just back and forth, a la Texereau. As the curve deepened, I tracked its sagitta first with a ruler across the face of the mirror, and, as the depth got closer to my goal of f/7, I wetted the mirror and measured the radius of curvature with the reflected image of a flashlight. And I kept track of the progress in a stenographer's spiral notebook (which I still have).

Every day after school, I would grind some more, eventually going through finer and finer grits. As per Texereau, I paid scrupulous attention to cleanliness, ensuring that everything was well cleaned between grit changes to prevent contamination. I didn't want to go through all that work and have a large scratch show up from a stray left-over grit.

I think I over-did the fine grinding grits, because I wanted to ensure the previous size pits were all gone before moving on. After several months, it was ready for polishing. I distinctly remember my Dad looking at the finely ground (frosted) glass and saying that would never be a mirror. He didn't see how it was possible. But I trusted Texereau.

Using Dad's homemade table saw, I made a wooden tray with slots in which to pour the pitch, so they can easily be cut into squares with a hot knife. Before I poured the pitch into the mold, I tested the pitch hardness by doing several smaller pours, letting it cool, and used my thumb nail (again, following Texereau instructions). After a few iterations (adding a drop or two of turpentine to the pitch pot each time), I was satisfied with the viscosity and poured the hot pitch into my homemade mold. When the pitch in the mold had cooled, I coated the tool with melted beeswax (to help the pitch to adhere), marked the tool with one-inch squares, and carefully cut the pitch, placing each square (one-quarter of an inch thick) in its designated place on the glass tool. Finally, I coated with pitch lap with a watery polishing rouge mixture and carefully set the finely-ground mirror on top, along with a magnet I used as a weight. Finally, I covered the whole mirror/tool setup with a damp cloth to prevent its drying out.

The next day, I removed the mirror (fortunately, it hadn't stuck to the pitch – one of my fears), and the new pitch lap looked perfect. With a camel hair's brush, I coated the tool with a slightly less watery rouge mixture and proceeded to polish with short W strokes. I, of course, varied the strokes and alternated with mirror on top and tool on top to ensure there weren't biases that would affect the mirror's shape. I was shooting for a perfect sphere.

But now it was time for a Foucault tester. Again, using my Dad's table saw (and a hand coping saw to make the curves), I made an exact copy of Texereau's Foucault tester. For the "micrometer" lateral adjustment, I found a half-inch fine-threaded rod in Dad's vast collection of junk. I then found a 2-inch steel cylinder I could attach to the rod with three equidistant screws. But I needed a scale. By counting

the threads per inch on the rod, I knew how far each revolution moved the Foucault carriage (to which the rod was attached). I then marked divisions on the 2-inch cylinder, so I could read small lateral carriage movements.

Finally, the tester needed a cage with a light bulb, a slit (two razor blades covering a one-eighth inch drilled hole in the cage), and a knife-edge (another razor blade). Voila – the Foucault tester was finished (and looked amazingly like Texereau's prototype).

Back to polishing. Things went fairly smoothly, although testing revealed a small central depression and turned edge (all common defects). But I used Texereau's figuring advice and applied pressure where needed to get it back to a sphere. Each figuring step was again documented in my notebook.

After 20 hours of polishing and figuring, the Foucault test showed a null across the whole face of the mirror, which indicated a perfect sphere. Dad was shocked to see the mirror so smooth and reflective. It was time to start parabolizing.

I wanted a long focal length mirror (f/7) for planetary detail, so the spherical surface didn't deviate from a parabola very much. If I was content with ¼ wave, I could have left it as a sphere and called it finished. But I was shooting for something better than 1/8 wave peak-to-peak deviation from a parabola, so I needed to deepen the centre somewhat to obtain a true parabolic surface.

But first, I had to make a Couder mask, so I could use the Foucault test to determine nulls on specific zones of the mirror (rather than the whole face). Again using Texereau's instructions, I calculated the zonal radii, using the mirror diameter and focal length as the only input parameters. I then carefully cut out the mask from a manilla folder. Of course, I still have that mask.

Now, with longer W strokes and mirror on top, I used the classical parabolizing method in which my mentor Texereau instructed me. This stage wasn't too difficult. I constantly tested progress with the Foucault, adjusted strokes accordingly, and re-tested. The optimal lateral position of the Foucault test carriage to null each zone of the Couder mask was calculated from equations provided in Texereau. Eventually, I got each zone to null nearly exactly where it should – within the limits of my tester and my own eyes (which had to judge a zonal null in zones on opposite ends of the mirror's face). But how close was the surface to a "perfect" parabola? I decided to make many independent measurements of the zonal nulls and average them all out. Over several days, I took 12 independent readings. All were quite close, varying by only a few divisions on my Foucault tester micrometer. But I now had a solid average that seemed reproducible and with which I had confidence. But could those readings be converted to an actual deviation from an optimal parabola (in wavelengths)? For that, I needed calculus! Rich, of course, had just taken a calculus course in his first year in college. So I asked him to teach me. Needless to say,

that didn't work out too well. The next best step was again to resort to Texereau. He had a graphical method to estimate slopes and deviations from an optimal parabola. Using his method, I calculated the deviation of my mirror from the best parabola was 1/42 wave. I didn't believe that number, but I was confident it was a "good" mirror. And it just took about one year start-to-finish. Now, I needed to get it aluminized and mounted in a telescope tube. Those things would have to wait for many years to come. More about that later.

I didn't realize it at the time, but this was the start of my mirror-making business. I really enjoyed grinding, polishing, and figuring my 10" mirror. Could I make some money by doing this as a business in my spare time (after school)? I checked out "Sky and Telescope" (S&T) and wrote to their advertising department. A commercial ad was astronomically expensive and required all sorts of corporate information. So I looked at the classified section of S&T called "SkyGazer's Exchange". For a few dollars, I could place an ad that would be seen by thousands of astronomy enthusiasts. I wrote up the ad and sent in a cheque. My ad appeared in the December, 1963 issue of SkyGazer's Exchange.

It wasn't long until queries (and some cheques) arrived in the mail. Some wanted a complete 6" mirror. A few wanted an 8" mirror. One 8" mirror was partially finished – they sent it to me to complete, having given up themselves. One request was for a 3" optical flat. The latter was my most challenging job, but all were completed and delivered to satisfied customers. This work kept me busy for a few years (after school and during school breaks).

This ATM work started in my high school years. But how was that possible? Wasn't there homework that needed to be done? Well, I went to Steinmetz High School. Academically, it wasn't the greatest. In fact, it was the subject of a year 2000 movie (starring Jeff Daniels) about a 1994 cheating scandal. I attended years earlier, but it was an "easy" school. I was in Advanced Placement (AP), which simply meant we received one point higher in grade (for instance, a B was 4 points rather than 3, and an A was 5 points). Some students (including me) actually graduated with more than an A average. And the coursework / homework was far less than those on the "normal" track. Teachers expected good students in AP, so gave them the benefit of the doubt. Was it fair? Not at all! But I benefitted – it gave me free time to do ATM work and even observe in the evenings.

In September, 1963, I was on the back porch with my mother, paging through the Chicago Tribune. Not usual for me – I still don't know why I did it that day. But a small article caught my eye. It mentioned astronomy. A bearded gentleman by the name of Dr. J. Allen Hynek was shown. The article mentioned that he was Chairman of the Department of Astronomy at Northwestern University and was starting a special Saturday morning program for gifted high school students called the Astro-Science Workshop. The students would be taught by world-class experts in their fields, giving university-level lectures in their fields of expertise. Observing time at Northwestern and Yerkes Observatories would also be offered. School councillors would be alerting potential students, but students were also invited to apply

directly. There would be a rigorous vetting process, since fewer than 50 students would be selected to participate.

I nearly fell off my chair. Without blinking an eye, I started to write my letter of interest to Dr. Hynek. It was posted the next day.

I knew my school councillor would never let me (or anyone else) know about this opportunity. This was Steinmetz, after all. I later learned that most students from elite suburban schools like New Trier or Chicago schools like University of Chicago Laboratory School were invited by their councillors. I thank God I read the paper that day.

The vetting process was multi-layered. They needed school transcripts. No problem. Then, I was asked to write a 500-word essay on some aspect of astronomy. Again, no problem. Finally, there was the interview with Dr. Hynek himself. Surprisingly, I wasn't nervous and that went quite well. I didn't know it at the time, but Dr. Hynek was quite famous as both an astronomer and as a UFO expert. For 20 years, he was the scientific consultant to Project Blue Book and coined the expressions "Close Encounters of the First, Second, and Third Kind." A few years later, he was the scientific advisor (and appeared in) the movie "Close Encounters of the Third Kind."

Later that month, a telegram was delivered to my parents' house. Who would send us a telegram? Who died? No, it said that Dr. Hynek was pleased to inform me that I had been selected to participate in the very first Astro-Science Workshop! I was in!!

The whole Astro-Science Workshop (ASW) experience was nothing short of amazing. Dr. James Van Allen talked to our Saturday morning class about the Van Allen radiation belts. The next Saturday, Dr. William Hiltner talked to us about photoelectric photometry. And on and on. After each lecture, a laboratory was prepared by a grad student to give us hands-on experience. We'd compute orbits. We'd compute radial velocities from stellar spectra. And so forth. I still have those lab sheets and lecture notes. For publicity, we had individual pictures taken. Mine was with Dr. Karl Henize, a Northwestern astronomer who became an astronaut (Apollo and Challenger) but died on Mount Everest. That photo is now on my desk.

And, of course, we had observing sessions. To get to Northwestern's Dearborn Observatory from my house required a long bus ride and an elevated train (subway) ride. In the evening, returning at 2 or 3 in the morning. In Chicago. Again, quite an experience.

The 1963-64 ASW program ended in May, 1964. Since I started high school in February (I was born in February), I would normally have graduated at the end of January, 1965. But that meant I'd have to wait

until September, 1965 to start university. Not me. I had plenty of high school credits (I was taking extra courses each year and even took a college first year English course to get it “out of the way”), so I could take one course in summer school and graduate from there. That’s what I did. I graduated Steinmetz in August, 1964 as Valedictorian of my class of 25. My normal 1965 graduating class would have been well over 1000 students.

After graduation, going to university was a no-brainer. My grades were great and my SAT scores were very good. I could choose any university I liked, as long as I (or my parents) could pay for the tuition. I was eligible for the full National Merit Scholarship, but that required a disclosure of my family’s finances. My parents would not hear of that. They were private people and would disclose their finances to no one. So I was on the hook to pay for both tuition and room and board. My parents and I agreed that my summer jobs would pay for much of it, but they would lend me the remainder. I would pay the loan when I could.

I wanted to study what I loved. A future job was of absolutely no consequence. I obviously loved astronomy. But I loved physics, too. And one of my brother’s close friends, Paul Grossgut, had just graduated in physics from a small college 25 miles west of Chicago. Most importantly, this little college was affiliated with Argonne National Laboratory (a major physics research institute nearby) and many of the college’s professors were also Argonne researchers. The college had 800 acres, small classes, and a world-class physics faculty. It seemed perfect. Its name was St. Procopius College. It is now Benedictine University.

St. Procopius (Proco) was an absolutely great experience. The faculty was small but outstanding. Two of the best teachers I ever had were at Proco. Dr. Rose Carney was head of the math department and was truly an inspired teacher. Fr. William Shonka, Ph.D. was head of the physics department and was equally a great teacher. Both were University of Chicago alumni, having worked on the Manhattan Project under the great Enrico Fermi and Richard Feynman.

Although Proco was wonderful, I missed my other love – astronomy. In my second year, I was starting to look at other schools which could offer a double major – physics and astronomy. I applied for and was accepted by the University of Kansas in Lawrence. It had a small observatory, small astronomy staff, and a respectable physics department.

Just before I left Proco in June, 1966, I had a request from a classmate which I couldn’t refuse. My friend was dating a senior in high school who wanted to double date with her girlfriend. She actually refused to go on another date with my friend unless it was “double.” So my friend begged me to join him. He was a very nice chap, and I couldn’t say no. He would drive, and the plan was to go to a local amusement park. It was April 29, 1966.

We drove up to my blind date's house in Lyons, Illinois and I rang the bell. The rest is history. The girl who answered literally knocked my socks off. Her name was Gloria. We talked all during the date (didn't even go on any amusement park rides), I took her to her Senior Prom in the following month, and we married on June 7, 1969. Together ever since.

Kansas was a good experience, too, although long-distance dating with Gloria was difficult (but we wrote every day). Two slight regrets – the double major didn't quite get me the number of physics courses I'd like (I wanted a few more advanced quantum courses and a group theory math course) and the astronomy courses concentrated on practical astronomy (positional work) rather than on astrophysics. And there was no real observational practice with the 27-inch reflector (although we had free use). Still, I wouldn't have changed it.

The Vietnam War, of course, was going strong in 1968. And I just lost my student deferment from the dreaded Draft. I was "1 A" and was promptly invited by Uncle Sam to appear for my physical exam. In my last year at Kansas, one of my physics professors (Dr. Richards) made it his duty to help his students stay alive. He counselled how to fail the physical and, if drafted, how to keep away from the front lines. Apparently, there were 10 levels of jobs in the Army. The first level was on the front lines. The 10th level was far away from the front. Teletypewriter repair was considered Level 10. Dr. Richards said that any physics major could easily follow an army manual and repair those teletypewriters!

Fortunately, my mother's cousin was a family physician. Dr. Shalla wrote me a long, sad diagnosis of my many "ailments." I brought that to my physical. But I also walked with a fake limp, with shoulders at different heights. After a gruelling naked exam, a rather gruff Sargent yelled at me "you're rejected." Out of hundreds of others, I was the only one I saw who heard those words that day.

I was fortunate. Not so many others. One of my roommates at Kansas, Robert Scott, flunked out (because a professor lost his term paper) and he was promptly drafted. He perished two weeks after deployment.

The summer of 1968 held more pleasant surprises. I needed a summer job before I started grad school and wanted to apply to the Adler Planetarium. That was part of the Chicago Park District, which meant it was a political job. You had to have connections. Fortunately, my mother had worked for years as an "Election Judge", meaning she had connections with her Alderman, who knew the Mayor himself. She put in a good word for me and, sure enough, I was accepted. For the entire summer, I was part of Adler's Astronomy Department, answering queries from the public and giving tours and lectures. Caroline, the secretary, was most memorable. She always carried a loaded "45" in her purse for protection. One couldn't be too careful in Chicago.

Also in 1968, I took the Graduate Record Exam in Physics in preparation for grad school and did surprisingly well. So I applied to several universities. My dream university (which I thought I had no chance of being accepted to) was the University of Texas. They ran McDonald Observatory and had just dedicated the third largest telescope in the world – the 107-inch. They were in the process of upgrading their department and were seeking new talent. So it surprised me no end when my letter of acceptance came. In order to afford graduate school (I was now on my own – no more parental support), I needed an assistantship (which came with full tuition forgiveness). I was hoping for a research assistantship, since that was the purpose of grad school, rather than a teaching assistantship, which would take an unnecessary 20 hours per week away from my studies. So the acceptance letter was bitter-sweet. They couldn't afford a full-time research assistantship in the Department of Astronomy. Rather, they offered me a half-time assistantship in astronomy (millimetre wavelength radio astronomy) and half-time assistantship in the Department of Engineering (millimetre wavelength propagation). I guess they read my ham radio background! Anyway, that wouldn't have been my first choice (I was interested in both interstellar matter and pulsars), but this was McDonald – I couldn't refuse. I happily accepted.

In retrospect, that may have been a wrong decision. But things started out well. Very soon after joining, I had to take the Ph.D. candidacy exam. Either a student was a Ph.D. candidate or was relegated to the "lowly" Master's program. I took the exam and easily passed. I was now a Ph.D. candidate! Just needed some coursework and a Ph.D. thesis. But to do a thesis, one needed to do research. And have a research advisor.

My advisor was also paying my research assistantship bills (from his grant) – Dr. Bruce T. Ulrich. Dr. Ulrich had just come from an industrial environment to join academia, where he was researching superconductivity – specifically, Josephson Junctions. He now wanted to apply Josephson Junctions to astronomy. He knew they responded to far infrared (millimetre wavelength) radiation fairly noiselessly, in contrast to traditional millimetre radiometers, which suffered from considerable infrared noise. So he wanted a helper, which turned out to be his research assistant (me).

We often drove the 500 miles to McDonald Observatory from Austin in Dr. Ulrich's Karmann Ghia. We loaded the superconducting gear into his little car, but during one trip, he forgot the large rubber bladder needed to transfer the liquid helium from its dewar to the Josephson Junction tank. So, on the way, we stopped at a little store to purchase a supply of condoms. Turns out the condoms worked perfectly to supply the needed pressure to transfer the liquid helium!

In June, 1969, Gloria and I were married. For our "honeymoon", we drove from Lyons to Fort Davis, Texas (McDonald Observatory) to live the summer on the mountain. We caught the August, 1969 moon landing through a "borrowed" cable connection. McDonald was one of two observatories which fired laser beams at a reflector placed on the moon to measure precise distances.

Working at the observatory, I found it fascinating to attach the Josephson Junction to the coudé focus of the 107-inch telescope, which had a fused quartz mirror and was very reflective in the far infrared. We observed the sun (with black polyethylene covering the front end to cut off the visible light), Jupiter, and the Crab Nebula. Fairly good results. But nothing outstanding. And nothing worthy of Ph.D. – level research.

My "research" in the Electrical Engineering department was even more underwhelming (paid for by the Defense Department). Dr. John Cogdell was my research advisor, and he was interested in calibrating the 16-foot millimetre wavelength dish antenna (gold coated for reflectivity) in both the near and far fields. I computed Gaussian near-field antenna beamwidths and did some observing with the 16-foot dish on solar system objects. Most of the "real" engineering research was given to Dr. Cogdell's engineering grad students. I had nothing that was remotely useful for a Ph.D. thesis.

Frustrated, I talked with the Astronomy Department Chairman, Dr. Harlan Smith. Dr. Smith was sympathetic, but defended Dr. Ulrich as a recent industry hire who was only interested in furthering his own research. Dr. Smith also had his hands full with other concerns, such as the very recent suicide (by hanging) of an astronomy grad student (I knew him slightly). Stress in the department was high.

In February, 1970, I decided that my research was going nowhere, and it was not an option to change advisors (all research grants were spoken for). My wife and I decided to leave Austin (which we both didn't like, anyway) for a new adventure.

Back in the Chicago area, I now had to find a real job. But what was I skilled at? There were no astronomer openings in Chicago! And then I thought about my experience in the far-infrared. This was millimetre wavelength, which was fairly close to microwaves. And who uses microwaves? The telephone company! So I applied to Illinois Bell (downtown Chicago) and was accepted as a "Special Services Engineer in Data Design." It paid well. We could even afford a house!

On my first day on the job, I was taken out to lunch by the District Manager. His words echo in my mind to this day. "You know, son, we have big plans for you. But the job must always come first. Ahead of your family. Ahead of everything else." I was stunned. But said nothing.

Gloria and I had a great start in our marriage. We travelled both within the U.S. and to Canada (Ontario, Quebec, and the Maritimes). And, with no kids, we saved some money. Enough for a down-payment on a house. We started looking. Most houses we were looking at were in the $30,000 to $35,000 price range. But then we were shown a beautiful house in Hinsdale, Illinois, a rather expensive Chicago suburb. It was listed at $50,000, but we could afford it. Twenty percent down. We could handle the mortgage. So we made an offer and it was accepted, contingent only on financing. We went to several

banks, but each one turned us down! One bank manager even told us “sure, I’d like a $50,000 house in Hinsdale, too!”. So we gave up. And considered other options.

Was the corporate life for us? Did we want to play the District Manager’s corporate game? We had travelled in Canada and loved the whole atmosphere. And I had a rudimentary knowledge of French (through courses in both high school and university). So we sent for real estate sales information for Canada, and the brochure we received listed a few possibilities. One place near Moncton, New Brunswick had 10,000 sugar maples. Intriguing! We sent for an application to become landed immigrants. And we did more travelling up North. When we arrived in Ottawa, we thought we’d found the perfect place. Although it was a “city”, it wasn’t nearly as vast as Chicago. And the people were wonderful. The place was beautiful, too, with parks, greenspace, and great shops. A wonderful place to raise a family! And our immigration was finally approved (after a year’s wait). So, in February, 1973, we went to a realtor in Ottawa and was shown a townhouse in Beacon Hill we could afford ($19,000 CAD). In March, 1973, we crossed the Ambassador Bridge with a small U-Haul trailer as landed immigrants in Canada. That U-Haul trailer contained all our belongings, including that 10” astronomical mirror completed some 11 years earlier.

Our new start in Canada was challenging but rewarding. Our son was born in October, 1974 at the Ottawa Civic Hospital. We had the same OB/GYN (Dr. Gluck) as Pierre and Margaret Trudeau (Justin was born a few months earlier at the same hospital). In 1979, we purchased 5 acres in rural Oxford Mills (80 km from Ottawa) on which we started to build a house. I also finished my somewhat delayed grad school doing part-time research. Relying on my Texas experience in superconductivity, I joined the low temperature team at the University of Ottawa and picked up my Master’s in 1982 and my Ph.D. in 1985 (Type II Superconductivity).

After a few jobs with fits and starts (Consolidated Computer Inc., which closed, Systems Dimension Ltd., which closed, etc.), I landed an engineering position with Bell Canada. Then, in 1982, I applied to a new Ottawa telecommunications research organization, Microtel Pacific Research (MPR), owned by BC Tel. I was eventually promoted from Member of Technical Staff to District Manager, responsible for 40 engineers who helped define Canadian international telecom standards (in Geneva). Our group also helped develop ISDN and Asynchronous Transfer Mode technologies, which were purchased by NewBridge and others. MPR ceased operations in 1997, when I became a full-time IT Security Consultant and Adjunct Professor of Astrophysics at the University of Ottawa.

During all that time, I tried to follow the latest news in astronomy the best I could. Although I didn’t subscribe to Sky and Telescope, I occasionally picked up an issue. One issue, in 1991, had a small ad for a “VernonScope Auction” in Vestal, New York, a mere 5 hours from our rural home in Oxford Mills, Ontario. It featured an array of antique telescopes, books, and related paraphernalia. I had to go! I sent for a fully illustrated catalogue. When it arrived, I couldn’t let it down. I immediately made a list of all the items I was interested in and the maximum bid price I was willing to go. One such item was an 1856

Henry Fitz mahogany telescope tube from West Point Military Academy. I was always fascinated with wooden telescope tubes ever since I gaped in awe at the 18.5" Clark tube in the basement of Adler Planetarium. It would make a wonderful telescope if I could only supply the lens. The original lens was with a steel tube replacement (also at the auction), but I knew 1856 optics would not be as good as modern optics (and I wanted perfection). So my goal was to pick up the wooden tube (if I was the successful bidder) and pass on the original lens/steel tube (unless the bid price was very low). I'd find a way to replace the lens – after all, making an achromatic lens was always a goal of mine.

The bidding on each item was exciting. But when my mahogany tube came up, there was silence. The tube was not in great shape. Some large cracks, missing veneer, etc. The bidding started at $1000. I sat on my hands. The auctioneer started to lower the asking bid. "Do I hear 800?" Nothing. The auctioneer eventually pleaded "Anybody want firewood?" "Last ask - $100". I raised my paddle. And won.

Going home (across the border) was interesting. I had a large 12-foot long wooden tube (somewhat resembling a cannon) strapped to the roof of my car. The border agent asked a few questions but let us through.

Those VernonScope auctions lasted for several years. Sometimes once per year, sometimes twice. But always with lots of "goodies." One year, I picked up a 1/20 wave optical flat (with test sheets) previously used in the Alvan Clark factory. Another year, I picked up an 1840 Merz 6 ¼ inch mahogany tube previously at Dartmouth College, along with 6 ¼ inch lens blanks suitable to make the replacement lens.

As soon as I brought the Fitz tube home, I started to plan for its new lens. I ordered optical glass catalogues from Schott, Ohara, and Hoya. But what glass to choose? I wrote a program in Basic to run on my little PC. It took glass data and design parameters (such as desired focal length and constraints such as R2 approximately equal to R3) and went through iterations to determine minimal longitudinal aberrations for each colour and minimal offence against sine (affecting coma). This program literally ran for weeks but permitted me to pare down the number of glass options to relatively few. I then ran those few glass types through OSLO and my own HP-97 (programmable calculator) programs to finalize on one "best" combination which met all my parameters. I finally chose LAC14 (lanthanum) and FD15 (dense flint) using published refractive index and abbe (dispersion) numbers, but I knew I'd have to optimize it further when I received actual melt data.

Then I started writing letters of inquiry, asking Schott, Ohara, and Hoya for quotes. I stipulated "precision annealed" and wanted the optical blanks to be relatively thick (1.4"), since my experience with mirrors made me cautious about flexure that might occur during polishing/figuring. And I sent those letters to both U.S. headquarters and overseas locations (Japan and Germany).

I received replies from all three U.S. firms and one Japanese firm (Hoya). The U.S. quotes were quite astronomical – greater than $10K. The Hoya (Japan) quote was in Yen, but, upon conversion to Canadian dollars, was quite reasonable (in comparison). I obtained a bank draft (in Yen) and placed the order with Hoya.

I waited months but finally received my precious shipment (very well packed). Detailed melt data was included. I immediately set to optimizing my design. I finally settled on the optimal radii (R1, R2, R3, and R4) to produce the desired focal length (I was targeting f/18-19), least chromatic aberration, least spherical aberration, and least coma. OSLO was useful in that, but I found my custom HP-97 (now running on an HP-48) programs to be even better for my purposes. I always compared final results with OSLO to provide a cross-check.

Now, I needed the test apparatus. I constructed a very nice wedge tester with a .0001" accuracy micrometer. I also made a spherometer, again using a very accurate micrometer in the centre of its 10 cm diameter. I knew that the exact centre was subject to some error, as was the location of its three legs. Even the small diameters of its glass ball feet needed to be accounted for (spherical feet would measure slightly differently for convex and concave surfaces). So I did a detailed error analysis, even though I calibrated it on an optically flat surface and with convex/concave surfaces of very nearly the targeted radii.

I then made a new Foucault tester, using much more sophisticated materials than my original (1962) version. I even made a Bath interferometer to obtain more objective and quantitative results.

Before I even started on the new achromat, I wanted to use my recently completed Foucault tester and Bath interferometer on the still un-aluminized 10" mirror from 1962. Would it compare to my teenaged measurements – 1/42 wave? Well, I used the original Couder mask on my mirror and the Foucault test gave very similar results as I had recorded in my old notebook. But the real test was the interferometer – what was quantitative reading? Setting up the Bath wasn't difficult. I found a good set of fringes and took several photos. The results – the wavefront error showed a maximum peak-to-valley deviation from an optimal parabola of 1/40 wave! To me, this was nothing short of astonishing. I took several more independent readings, making sure the software was set up correctly. Similar results.

Since my new achromat had 4 surfaces to grind, polish, and figure, I obtained 4 Pyrex tools, each 1.5" thick. I also got a new 3-ring binder, with separate sections for each surface – R1 to R4 (to chart the progress) and two other sections to chart the wedge for each lens element. I set up a new grinding stand (a 55 gallon drum, securely bolted to the cement floor) and started grinding.

The grinding technique is no different than the technique I followed years ago for my many mirrors – Texereau was still my Bible. Short W strokes kept the surfaces pretty spherical. After each grinding spell, I'd check the wedge. If one side of the blank was a bit too thick, I'd mark that side with a water-soluble marker and apply a bit more pressure to that area when grinding. With that method, I was able to keep wedge down to the limit of my micrometer reading, all through fine grinding.

Since R3 was concave (similar to a mirror), I ground that first and measured its radius of curvature fairly accurately through the spherometer (at first) but refined the measurement through reflection – with water sprayed on the surface. R2 was coarse ground on the tool, but fine ground against R3, resulting in nearly identical, but complementary, curves. R1 and R4 were ground exclusively on their respective tools. For spherometer measurements, I used R2 as a calibrating surface. I knew its radius of curvature through reflection and computed new spherometer parameters for that concave radius. I assumed R2 had the same (but convex) radius (since the two were ground on each other), so I used the spherometer to measure new parameters for that convex radius. R1's radius was fairly close to R2 (close enough for calibration purposes), so I used the R2 spherometer parameters to measure the radius of curvature of R1. R4 was nearly flat, so I computed new spherometer parameters based on calibrating the spherometer against an optical flat (I had obtained a 21" optical flat from a government surplus sale). I now knew all spherometer parameters for all relevant convex and concave radii and could refine the actual glass radii based on my design, with some confidence that the spherometer measurements would give reliable and reproducible results.

Fine grinding proceeded smoothly. Through each grit, I measured the radius of curvature of each surface such that the surface deviation from goal could not be larger than the current grit size.

After completing 3 micron fine grinding, I constructed 4 separate pitch laps (again, using Texereau's method of placing individual squares on the tool) and started polishing with optical rouge.

This again went smoothly. Using varied and somewhat short W strokes (alternating lens on top with tool on top), I tried to ensure sphericity. R3, of course, could be directly measured with the Foucault tester. After a "perfect" sphere was obtained with R3 and the other surfaces were well polished, I assembled both elements in an autocollimation mode (against the 10" optical flat from Alvan Clark – previous purchased at auction). From that point, it was a matter of small local polishing (mainly R4, which was the flattest) to obtain a perfect null in the Foucault. When I was satisfied, I did a further refinement using the Bath, which was more sensitive to deviations from an optimal surface. The result was a 0.98 Strehl ratio, which I considered to be as nearly perfect as possible for an achromat (in an achromat, it is not possible to focus all energy entirely within the Airy disk).

I then assembled the doublet in a special cell and set it up outside, within the light path of some bright stars. With a high power eyepiece, I viewed the Airy disks of those stars. It was as perfect as the seeing allowed. I was now even more confident that this was a good lens.

Since the glasses I chose had fairly high indices of refraction, they were subject to considerable reflection losses (nearly 5-6% per surface). I therefore wanted them low-reflection coated. But I dare not risk having the glasses heated, as is normally required for a magnesium fluoride coating. Besides, MgF2 was not optimized for my high index glass. Instead, I opted for an ion-sputtered "cold" coating performed by Evaporated Coatings, Inc., Willow Grove, PA, using ECI #149. Average reflectance per surface measured 0.34% @ 450-650 nm. Needless to say, I hand-carried the lenses to ECI and personally picked them up when completed.

Now, of course, I needed a lens cell to fit in my newly restored 1856 Fitz mahogany tube. Although I considered doing the brass casting myself, I thought that this might be better "farmed out." After many inquiries, I found Peak2Valley Instruments, UK, able and willing to make the cell according to my specifications. I placed the order and, a few months later, an absolutely beautiful brass cell was delivered. I am now in the process of completing the focusing end of the optical tube, mounting it (I've obtained 5-inch diameter stainless steel axes for the purpose), and installing it in my self-constructed 3-story 20-foot diameter observatory (still under construction).

Mirror and lens grinding was now firmly in my blood. A made a 6 ¼ inch achromat to fit my 1840 Merz tube and polished/refigured a 6.5" Cooke photo-visual triplet which had considerable fungus growth / etching on its middle element. I plan on a 9-inch achromat to fit my 1863 Henry Fitz tube, acquired from Afred University. And I've obtained lens blanks for several other achromats.

I previously mentioned the wonderful VernonScope auctions, with their great selection of antique telescopes. Through contacts made there, I was made aware of an 1880 6.5" Cooke telescope on a massive mount at Coventry Technical College, UK. It was being offered for sale by the Coventry and Warwickshire Astronomical Society (CWAS). It was July, 2001.

I, of course, was interested. I was fascinated with 6" telescopes ever since I saw an ad in 1961 for a 6" Unitron Photo-Visual – for the stately sum of $6000. That was a year's salary for most people in those days. After a few queries, I made an offer on the Cooke. It wasn't enough. After some negotiations, it still wasn't enough. My limit was passed. I'd have to give it up. I sent my regrets.

Then, in September, 2001, tragedy struck in New York. It was 9/11. Shortly afterwards, the CWAS contacted me. Was I still interested? Apparently, the high bidder lost someone close in 9/11. They needed to withdraw their bid. My next lower bid was accepted, and I sent a cheque (in UK pounds) to the CWAS. The scope was shipped to me in two large wooden containers which I picked up at the shipping port in Montreal.

Shortly afterwards, I started construction on a 10-foot diameter domed observatory. I purchased a galvalume hemisphere from Demuth Steel in Waterloo and constructed the bi-parting shutters myself. The telescope and domed observatory are now nearly ready for use.

Along the way, I finally got my old 10” mirror aluminized and mounted in a hefty German equatorial mount. I’m working on replacing that mount with a go-to DOB. The views using this old mirror, made as a teenager, are outstanding!!

This story is not complete. It continues. My ATMing will continue until I can no longer push glass, restore brass, or wield a hammer. But it was (as is) fun.

…August, 2025